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CHIMERA IN HEAD OF SUNFLOWER

(Frontispiece)

This was found in the garden of Mr. J. D. Long at Boulder, Colorado in 1917. Some of the disc florets, roughly a third of the entire disc, show ligulate characters, as in the so-called double sunflowers. This may be attributed to a "bud sport" which arose at a very early stage in the development of the shoot producing the head.

T. D. A. Cockerell,
University of Colorado.

THE FUTURE OF DEMOCRACY

J. H. KEMPTON

THE superiority of man over the lower orders lies in his ability to control in a large measure his own destiny by interpreting the future in terms of the past. This advantage he owes to his development of elaborate methods of communication and especially of written records which permit a permanent record of experience. The wisdom of studying the past as an index of the future has long been recognized and has given rise to the adage that "hindsight is better than foresight."

Indeed, the extent to which a people has been guided by the experience of the past in determining its conduct furnishes a very fair index of the excellence of its civilization. The rather general belief that to progress we should look only to the future is not shared by men of science, whose activities are largely devoted to an investigation of the past in an endeavor to understand the future.

Taking advantage of our records of the past and applying the practice of hindsighting, it is found that with respect to human affairs history discloses two major trends among the welter of dynastic squabbles—an ever increasing population and closely associated with this growth of population an ever increasing control of government by the mass of the people. The relationship of population increase to the control of government by the masses is not entirely accidental and it may not be amiss to attempt a forecast of what this means in terms of future civilization.

The Individual and Co-operation

The first efforts of modern democratic civilizations were directed largely toward obtaining complete development and exercise of the abilities of the individual. To this end the doctrine of the freedom and equality of mankind was promulgated for the purpose of overcoming inequalities before the law. In this country a further effort was made to insure the unhampered development of ability, almost regardless of financial status, through the system of universal education supported by taxation. Under the stimulus of these two major changes from previous conditions there followed an unprecedented rise of the individual, which reached its climax late in the nineteenth century. Just prior to the close of the century the directors of large capitalistic enterprises awakened to the advantages of co-operation, advantages which the workers also were not slow to appreciate and grasp.

Accordingly, the trend of the twentieth century has been more and more toward co-operative efforts with a consequent submergence of the individual and an increasing clamor for government in business. So potent has co-operation become that now it is hailed as the panacea for all social and economic ills. Undoubtedly, there is much to be said in favor of co-operation as contrasted with unrestricted individual competition but the system as established at present is certain to break down if carried to its logical conclusion, with each individual enrolled in some organization.

The communists have foreseen something of the difficulties to be encountered in a conflict between large competing organizations and have attempted to avoid them by combining all workers in a single union. If successful, in the sense that the several conflicting groups such as agriculture and industry are subordinated to their proper spheres, human society will have become closely analogous to some of the well known social insects such as the ants or bees. Such organizations have proved to be long lived but we cannot lose sight of the fact that in these cases or organ-

ized insects there is little in the way of individual diversity, the separate parts having reached a dead level of ability. Whether the human race can be reduced to such a condition of individual uniformity is a question,—unless the future population of the world is to be derived in its entirety from the lower levels of mentality.

It is difficult to imagine what the incentive for existence would be in a world where all the products of one's ability were expropriated for the benefit of a less able class. Yet an organization of this sort is contemplated by the present communist regime in Russia operating with a conception which must be considered the ultimate in the socialization of political units. Presumably the only reward to be permitted for meritorious effort in a social organization of this sort is a certain smug altruistic feeling and it is hard to imagine that civilization would long continue to advance without more stimulus to achievement. It seems certain that the superior individuals, powerless to control their destinies in a manner commensurate with their abilities, would remain childless rather than subject their offspring to such conditions. With the obliteration of the hereditary lines embracing the able elements of the population would come the collapse of civilization. The disintegration of society as we now know it would not be cataclysmic but it would be none the less certain.

The general recognition of the fact that the destruction of civilization would not be sudden has led to a *laissez-faire* attitude on the part of many, since concern for the welfare of offspring beyond the stage of grandchildren is not a conspicuous human trait. Nevertheless if impending conditions are to be remedied the time for action is approaching rapidly and it behooves us to consider ways and means to prevent the control of civilization by those who have made the least use of it.

Government by the Inferior

Those who shrink from recognizing the unpleasant probabilities of government by the inferior have interpreted the recent elections in Great Britain and the United States as marking the decline of radicalism. From a consideration of past events this conclusion appears fallacious. The whole trend of modern history is one of increasing power for the proletariat, the past decade witnessing an unprecedented acceleration in this direction.

The rise of radicalism assuredly has not reached its peak and in so far as the recent elections mean anything at all they mark simply a temporary check in the march of the masses.

Whether the assumption of power by the masses is applauded or deplored depends upon how literally the doctrine of the free and equal status of all mankind is interpreted. In its strictly legal aspects the doctrine of freedom and equality is accepted at least in principle by all, but, unfortunately, the slogan has been given a broader application than the facts warrant. Biologists are agreed that in a biological sense the much-proclaimed equality of mankind is non-existent and cannot be attained.

If the inherent qualities of men are not equal, what does the future hold for governments founded upon equal suffrage? The population of the world is increasing at a tremendously rapid rate, which in itself constitutes a serious problem, but in addition there seems to be no question that the less able elements are reproducing at a more rapid rate than the gifted. It has been suggested that eventually an equilibrium will be reached between the competent and incompetent due solely to the fact that the latter depend for existence on the former, the relationship being one of parasite and host. While this seems as comfortable a conclusion as could be reached under the circumstances it can not be accepted as a certainty. It is true that if the population reaches the limit capable of

being supported by the food resources of the world a certain modicum of intelligent beings will be necessary to maintain it at this level.

Such evidence as exists, however, indicates that the intelligent element, hard pressed by the economic situation, is not reproducing itself and there is nothing to prevent the complete submergence of the competent individuals long before the maximum population compatible with the food supply has been reached. In this event the population would never attain the extreme limit but would become stationary at a point capable of being maintained by the efforts of incompetents.

The keystone of modern democratic states has been and still is education, but universal education has reached its peak and signs of a breakdown appear in the numerical limitations being imposed by our large universities. With a population composed of a large element of mentally inferior individuals it is a question whether universal education is not actually a detriment to the state. The old adage of a little knowledge being a dangerous thing would seem to apply here, and a little knowledge is all that a large majority are capable of assimilating. Practically every one can be taught to read but few can be taught *what to read,* the result being that the individuals possessed of a low mentality seek reading matter adapted to their intelligence.

The opinions of the majority of citizens are formed by the press and it is a prominent feature of our national life that a venial press always can be found to cater to the minds of the masses. Here it is that a little knowledge becomes dangerous since the voters of low mentality lacking discrimination are supplied with the most atrocious falsehoods with respect to governmental affairs and are filled with the most absurd economic theories. It is no accident that the revolutionary difficulties of our neighboring southern republic owe their origin to the activities of the semi-literate element of the population and not to the completely ignorant agricultural peon.

The "Parlor Pinks"

In this country the situation is further aggravated by the activities of a certain class of well-educated theorists commonly referred to as the intelligentsia or more humorously as "parlor pinks." These people almost invariably derive their incomes from money carefully invested in the safest capitalistic enterprises and in consequence are in need of an outlet for energies not used in a daily toil for subsistence. The majority of this class is composed of women who, relieved of responsibilities at home, seek an enlarged sphere of activity and imagine that in working for the political elevation of the masses they are "living a useful life of their own."

While many of these people obviously are insincere, having assumed a solicitous concern for the downtrodden as a pose, there are a surprising number of others apparently possessed of intelligence who in all sincereity are devoted to the cause of government by the proletariat. The former class will disappear with advent of newer fads but the latter element will persist until its aims have been accomplished unless through some miracle they should awaken to a realization of the inherent defects of their cause. Almost without exception these sincere advocates of the sovereignty of the masses are ardent champions of the biological equality of all mankind as indeed their position obliges them to be. Like the political opponents of evolution they place no confidence in the findings of biologists nor will they take the trouble to examine for themselves the facts which they reject, preferring to believe that the world is full of "unsung Miltons."

In families so unfortunate as to have some mentally defective children it is well recognized by all the members that such children require special consideration and their weight in family councils is never on a par with that of the normal offspring. The unfitness of

such children for tasks requiring mental ability is understood not only in families of high social standing and intellectual development but throughout all walks of life including even the uncivilized tribes of many regions. Yet, it is a curious fact that although the special nature of such cases is well recognized within the family there is a disinclination among our idealists to extend the knowledge thus gained, of the difference in individuals, to the broader field of the body politic. In state councils maudlin sentimentalism supersedes knowledge and an equal weight in the control of government is demanded for every individual regardless of mental fitness. This reluctance to admit in the people at large that which is so well understood in the family is due in part to the rather general belief that most of the feeble minded are confined in institutions and that the dividing line between normal and defective mentality is sharp, an individual being of either one or the other. This belief has no basis in fact, variation in mental capacity being fully as great as that found in physical ability, and although tasks requiring the exertion of strength are assigned to those best equipped physically to perform them, this practice is not followed with respect to political suffrage where the exercise of mental ability is required.

The present situation seems analogous to that which would obtain were a group of bicycle racers to compete simultaneously on a track where an automobile race was in progress. No one would deny that mutual advantage would accrue to both sets of contestants if the cyclists were transferred to a less hazardous location where their competition could proceed under more favorable conditions. It would seem to be misplaced humanity which encourages bicycle minds to interfere with the progress of minds of higher motive power to the detriment of both.

Those who have embraced the belief that all men are biologically equal at birth and regard education as a sort of philosopher's stone capable of transmuting the basest minds into the most able intellects always support their contention by the attractive and to them satisfying process of reasoning by anecdote. Their favorite procedure is to seize upon some prominent figure such as Lincoln and dwell upon the obscurity of his ancestry. The success of this method lies in the fortunate circumstance (fortunate from the standpoint of those who use it, but unfortunate from the standpoint of ascertaining the true facts) that the ancestors of but a few are recorded over a period of many generations.

As in the case of Lincoln, the unearthing of the facts often discloses the fallacy of this method of reasoning, but the true believer in potential equality seldom is daunted by such discoveries, making haste only to transfer the example to some other illustrious figure of unknown ancestry.

Government by Wealth

The desire to get something for nothing always is uppermost in the minds of the partially educated and it is to this desire that our educated socialists make their strongest appeal. The incentive for mass action tending toward the distribution of wealth increases as capital becomes concentrated in fewer hands.

While there are few data to determine whether the wealth of the world is possessed by relatively fewer people now than formerly there seems to be no doubt that the tendency is in this direction with huge fortunes being amassed by a very few families.

Whenever the masses clearly overbalance the capitalists, using the term in a broad sense, the stage is set for communistic action and while wealth up to a certain point can counteract the mere weight of votes the period is reached eventually when money control is no longer possible. It is a question whether a governing class founded solely on wealth is desirable but as

between government by the incompetents and government by the capitalistically successful there can be no question of the choice. Present day civilization measures intellectual merit largely in units of wealth but this need not necessarily be so. A governing class based on intellectual capacity is greatly to be desired but before a realization of this desire can be had it becomes essential to determine what constitutes intellectual capacity.

It will not do to lose sight of the fact that something in the nature of an intellectual aristocracy was attempted in China and failed. The failure in this case, however, should be attributed directly to the educational system which placed undue emphasis on memory alone rather than upon energy and innate ability.

Our present educational system is open to the same critiicism in the it is static rather than dynamic and while it provides a measure of a certain kind of ability it would not do as a standard for selection during a long period of time.

Measures of Intellectual Capacity

At the present time there is little agreement as to how best to measure intellectual capacity, especially in early life, except in so far as intelligence is inherited and can be predicted from the attainments of the parents. While the studies of the ancestry of superior individuals disclose that a few family lines have supplied a large proportion of the intellectually able, there can be no doubt that occasionally an able individual arises from an unpromising line. The converse of this also seems to be true that exceptionally able parents do not always produce able children. An hereditary aristocracy, therefore, can not long survive even though composed at the start of the best elements of the population. The ideal toward which we should strive is one where the intellectuals of whatever ancestry are assured a relatively large part in the shaping of civilization unhampered by the mass of mentally unfit.

Such an ideal can be attained only when it becomes possible to measure with some accuracy the potential ability of the individual at an age early enough to insure a long participation in the affairs of government. No such measure is available at present though a promising beginning has been made in the science of psychology. Unfortunately the outbreak of the War has had the effect of forcing the hands of the psychologists with the result that the application of intelligence tests has become more general than existing knowledge warrants. If carried too far on this basis the science of psychology is in danger of meeting the same fate as the science of eugenics which suffered a premature birth and has not yet attained normal vigor.

If reliable estimates of potential ability become possible before the increase of the masses has completely swamped the intelligent element and plunged civilization into the abyss, then a voter's qualification based on merit should be established. Although great effort is now necessary to get the voters to exercise their privileges, this effort is directed chiefly at the better element of the population, the more ignorant class voting with distressing regularity. Any effort, therefore, aimed at the disfranchisement of the mentally inferior would be met with overwhelming disapproval. The alternative is to give the desirable element more votes, their voting power depending upon potential ability and subsequently on their actual accomplishments.

Intelligence and Suffrage

A system could be devised whereby all citizens upon reaching their majority would have the privilege of casting a single ballot, those exceeding a certain intellectual potentiality being entitled to two ballots and various stages upward being provided for. Thus those who make use of their potential ability through certain educational advantages would be entitled to cast more votes than those who though potentially their equals fail to develop

in accordance with their superior intellectual equipment. In this manner an incentive would be provided for continuous effort to advance and the man of superior intellect would not be discouraged from exercising his right to vote.

The defects of the present system were envisaged clearly by Mark Twain, who advocated a system of weighted ballots with the following statement: "This endeavor to equalize what God has made unequal is a wrong and a shame. It is too late now to restrict the suffrage; we must increase it—for this let us give every university man, let us say ten votes, and every man with common school education two votes, and a man of superior power and position a hundred votes, if we choose. This is the only way to get out of the false position into which we have fallen." The sincerity with which this idea was entertained by Mr. Clemens is shown by the fact that an extravanganza by him embodying the above sentiments was published anonomously in the Atlantic Monthly, obviously to avoid the almost certain humorous interpretation it otherwise would have received.[1] His earnestness is further attested by the attitude of Mrs. James T. Field to whom he broached his ideas on suffrage and who was sufficiently impressed to record the following comment: ". . . . . such a change should be tried, since we cannot keep the untenable ground of the present.[2]

If an intellectual governing aristocracy of this type were once firmly established it would be able to control the reproduction rate of the mentally inferior of whatever ancestry, limiting the size of this class to that which could be supported by its own efforts under competent direction and the ascendency of the inferior resulting from a disproportionate birth rate would be no longer a cause for apprehension. Unquestionably the economic status of the inferior elements would be improved by birth limitation measures. Such limitation involves no abrogation of the rights they now enjoy but merely denies to them the position they are rapidly usurping through their disproportionately high rate of reproduction.

Unless some action of this sort be taken to counteract the undue weight of the vote of the inferior and an effort made to insure to the able a dominant voice in governmental affairs, civilization as it has advanced during the past few centuries is in real danger of extinction through a loss of the hereditary lines embracing the most competent individuals. Once these superior lines are lost, untold ages will be required before new able families can be developed by a reassembling of the genetic elements of their superiority through chance recombinations.

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2. Memories of a Hostess, Mrs. James T. Field, by M. H. DeWolfe Have, *Atlantic Monthly Press*. 1922.

The Anatomy of the Rat

A Laboratory Manual of the Anatomy of the Rat, by Harrison R. Hunt, Ph. D., pp. 123, price $1.50. The MacMillan Co., New York, N. Y.

This laboratory manual of the anatomy of one of the most easily obtained mammals should find a wide uses in classes in vertebrate anatomy. The descriptions are based largely on the author's own researches. Illustrations are purposely omitted in order that the students may get their visual impressions directly from the animal. It is written in such a clear style, however, that there should be no undue difficulty (and much pleasure) in tracing out the relations of the parts described. Occasional brief notes on the mode of development of parts, their evolutionary history, and on their physiological significance serve to keep the study or anatomy in its proper relation to a broad biological viewpoint.

S. W.

BREEDING WORK WITH HENEQUEN AND SISAL

RAFAEL VIDAL
United States Department of Agriculture, Mayaguez, Porto Rico.

HENEQUEN AND SISAL HYBRID
Figure 1

Left,—Sisal, *Agave sisalana,* with dark green leaves having no marginal prickles—the species of the staminate parent. *Center,*—first generation hybrid, with grey leaves like henequén but devoid of marginal prickles like sisal. The plant is about one year old. *Right,*—henequén, *A. fourcroydes,* with grey leaves armed with marginal prickles—the species of the pistillate parent. All three plants are young, but there is no significance in the differences in size.

HENEQUEN, *Agave fourcroydes,* and sisal, *Agave sisalana,* have each a number of characteristics which, if combined by crossing, might result in a type of plant most advantageous for commercial uses.

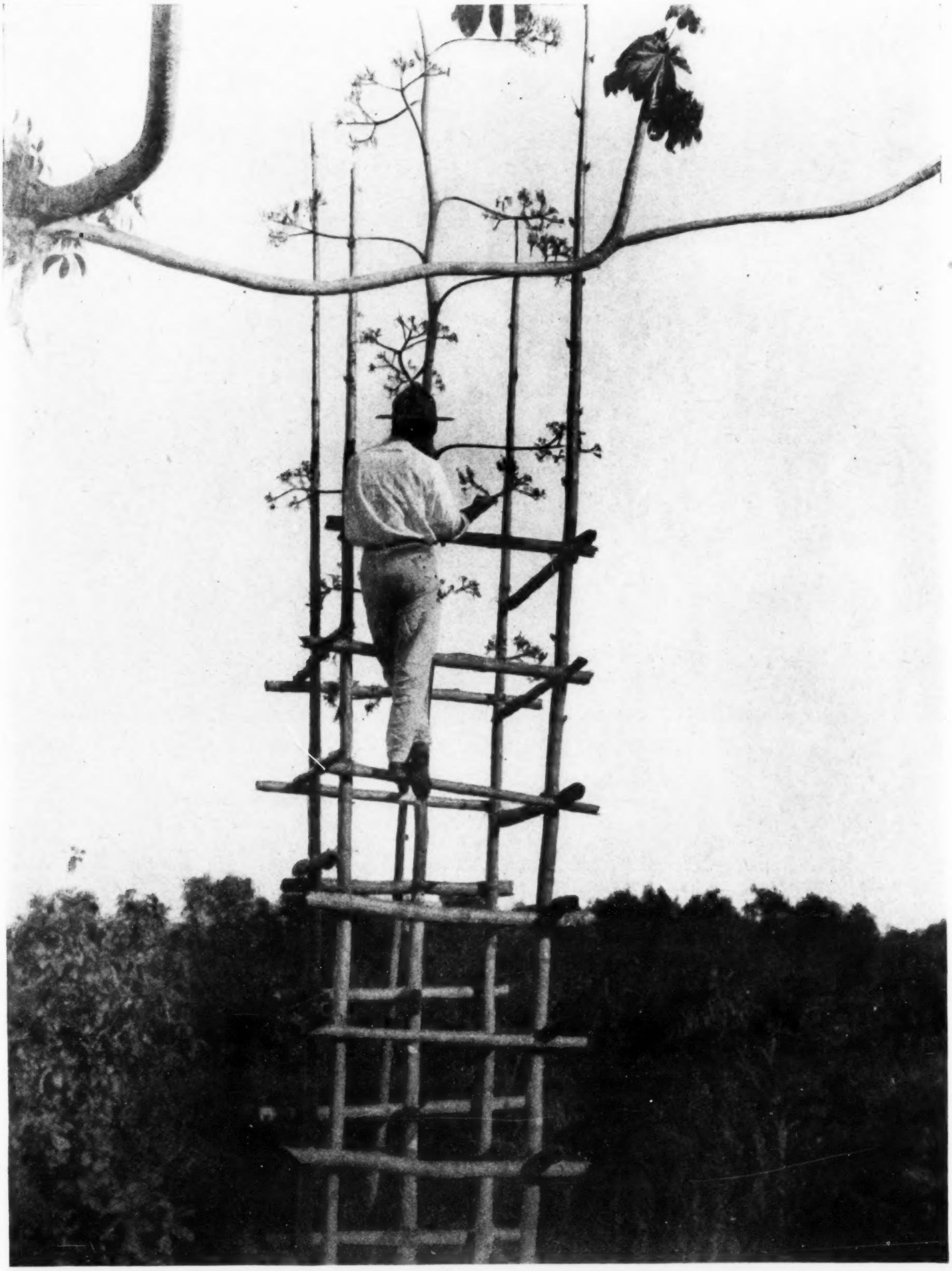
Henequén is longer-lived, more resistant to drought and certain infectous diseases than sisal, although it has very vicious marginal prickles.

Sisal has no marginal spines, produces a better type of fiber, develops faster than henequén, and is adaptable to a wider range of soils.

Two experimenters, Dr. L. Trabut in Algeria,* and Mr. William Weinrich in Hawaii† have already done some work in this or similar directions. However, the writer understands that Mr. Weinrich's plants were left to themselves in Hawaii and may have been lost or destroyed and that one of the parent plants used by Dr. Trabut has been lost to indentification.

In the winter of 1922-23 some reciprocal crossings were made by the writer between sisal and henequén at Mayaguez, Porto Rico. The results were negative when sisal was used as the mother plant. Sisal produces only bulbils and never seed-pods in its normal condition. Henequén produces both seed-pods and bulbils, often from the same flower cluster. When hene-

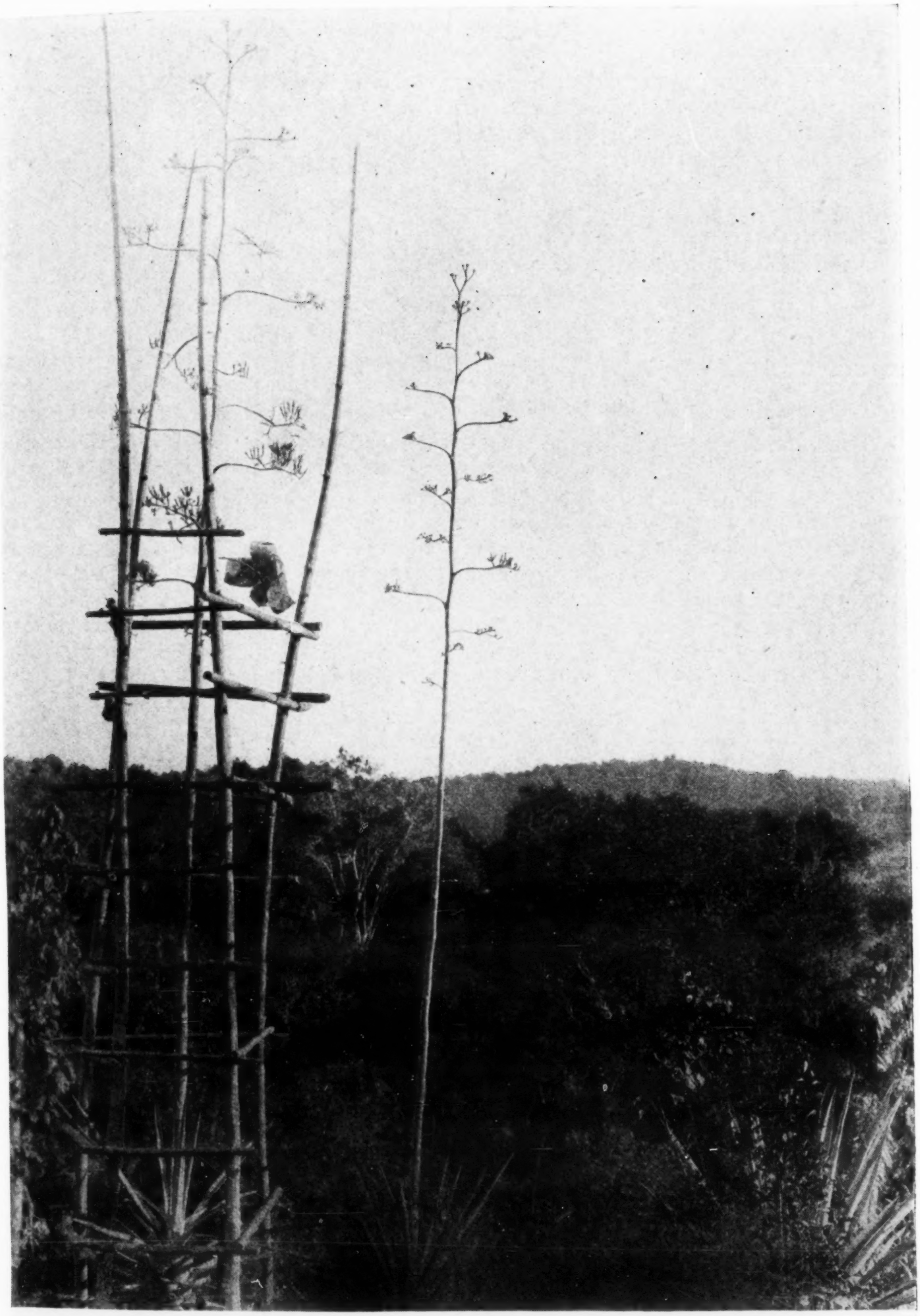
*JOURNAL OF HEREDITY, Vol. 13, No. 4.
†Letter to Mr. L. H. Dewey, in charge of Fiber Investigations, U. S. Department of Agriculture.



CROSS POLLINATION UNDER DIFFICULTIES

Figure 2

Examining seed pods on a henequén plant from flowers crossed with sisal. More than 300 flowers were cross pollinated, but only fourteen seed pods proved fertile, and all were on this plant.



HENEQUEN PLANT WITH FLOWERS BAGGED

Figure 3

A scaffold of bamboo was built to reach the flowers, from six to nine meters (twenty to thirty feet) above the ground. The stamens of selected flower clusters were removed before they shed any pollen and the flower clusters were bagged. As soon as the stigmas were receptive, fresh pollen from a selected sisal plant was applied and the bags were replaced.

quén was used as the mother plant, fourteen pods were obtained from which forty-three first hybrid generation plants are still living.

There exists a wide difference among these plants, ranging from that shown in the center of the accompanying photograph with the grayish green color of the sisal and very pronounced marginal prickles.

The plants are closely watched and their progeny will be carefully nursed.

Cross Pollination under Difficulties

The flower stalks of henequén and sisal are five to ten meters high, but not strong enough to support a ladder leaned against them. It was necessary to build a scaffold of bamboo around each flower stalk so as to climb up and perform the various operations in making the crosses. It was necessary that these scaffolds be strong, for the sharp spines on the agave leaves did not offer a tempting place to alight in case of accident. Scaffolds were built around a half dozen different plants before satisfactory flowers were found, for it was impossible to examine the flowers until the scaffold was built, so as to climb up an see them at close range. The sisal and henequén plants used in the successful cross were more than a kilometer apart where they had been introduced in the hills back of Mayaguez.

The flowers are large, the six stamens easily removed, the stigma easily accessible, and the pollen is produced in abundance, so that, except for the difficulty in reaching the flowers, the operations of cross pollinating are comparatively easy. The stigmatic surfaces are apparently not always receptive, for more than 300 flowers were cross-pollinated and only fourteen produced seed-pods.

Five Years of Livestock Improvement Summarized

Nearly 15,000 persons living in 752 counties of 46 States, in the District of Columbia, Guam, and Porto Rico have enrolled in the "Better Sires—Better Stock" campaign during five years since its inauguration October 1, 1919, by the Bureau of Animal Industry, United States Department of Agriculture.

Those who have enrolled, pledging to use purebred sires exclusively in their livestock raising, range all the way from boy and girl club members to owners of large ranches. In all, the 14,902 persons enrolled own a total of 525,522 animals and 1,117,928 poultry. This gives an everage of 35 animals and 75 poultry to each person enrolled.

On participating in the "Better Sires—Better Stock" campaign the livestock owner lists the number of animals he owns in the different classes of livestock, stating that the males are all purebred and indicating whether the females are scrubs, grades, crossbeds, or purebreds. States shown to have the greatest number of persons enrolled are: Ohio, first, with 2,917; Kentucky, 2,805; Virginia, 2,277; and Nebraska, 1,502.—*U. S. Department of Agriculture.*

INHERITANCE OF RATE OF FEATHERING IN POULTRY*

D. C. WARREN
Kansas State Agricultural College, Manhattan

FROM experiments involving crosses between the Single Comb White Leghorn and the Jersey Black Giant data have been obtained regarding a sex-linked factor which affects the rate of feathering. This character is exceptionally valuable for genetic investigations since it segregates in a clean-cut manner and is juvenile in expression. It is also of value in linkage investigations since its expression is not interferred with by the better known characters, most of which affect pigmentation.

It is a well known fact that in the case of the Leghorn breed, the chick down is very early replaced by feathers. In many of the heavier breeds of fowl this replacement takes place much more slowly. Rogers[1] in an early paper states that from a cross between White Leghorns and Barred Plymouth Rocks the offspring are all feathered like the father, regardless of the direction of the cross. Serebrosky[2] reported upon a cross between Barred Plymouth Rocks and Russian Orloffs from which he finds evidence for a sex-linked gene affecting the rate of feathering. If the rate of feathering in Barred Plymouth Rocks is determined by a sex-linked gene, Rogers' observations cannot be entirely correct. It is possible that the gene mentioned by Serebrosky is identical with the one discussed in this paper.

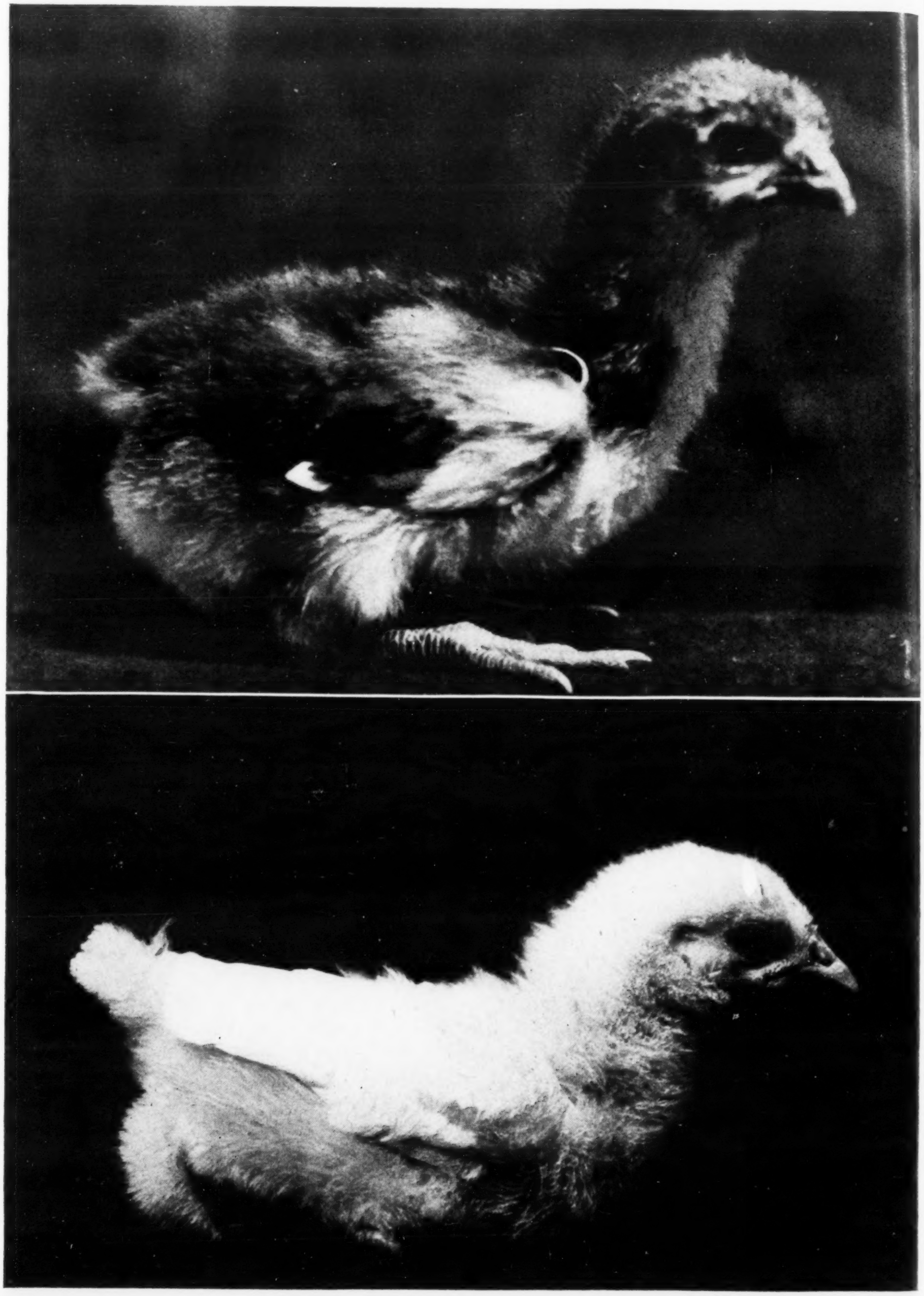
Method of Classification

In all breeds, the primary wing feathers are the first to appear, but there is a rather wide difference among breeds as to the rate of growth of these feathers. The tail feathers are usually the next feathers to appear. The age at which the tail feathers first appear was used as a basis for classifying the individuals recorded in these experiments. The first examination was made on the ninth day and later ones were made at weekly intervals until the chick showed a well defined tail. These weekly records of rate of feathering were made not only for the offspring from the crosses discussed, but also for a number of both pure bred White Leghorns and Black Giants. From the examination of over three hundred pure bred White Leghorns it was found that with only a single exception they showed tail feathers on the ninth day. This single exception could have been due to an error in records. (The chicks were removed from the incubator upon the twenty-second day of incubation and were considered as a day old at that time). Observations made as early as the fifth day after hatching indicated that practically all of the pure bred Leghorns showed tails at that time. No Black Giant chicks showed tail feathers at the examination on the sixteenth day and a large majority did not show them until the thirtieth or thirty-seventh day.

During these experiments all of the chicks of a single hatch were kept together, regardless of the type of cross. Thus the examiner, being ignorant of the parentage, could not be biased in making classification since indentification was made only by wing band numbers Also at the time of classification it was impossible to determine the sex of the chicks. The vigor of the chick seemed to have no influence

*Contribution No. 29 from the Department of Poultry Husbandry, Kansas Agricultural Experiment Station.

Jersey Black Giant Female



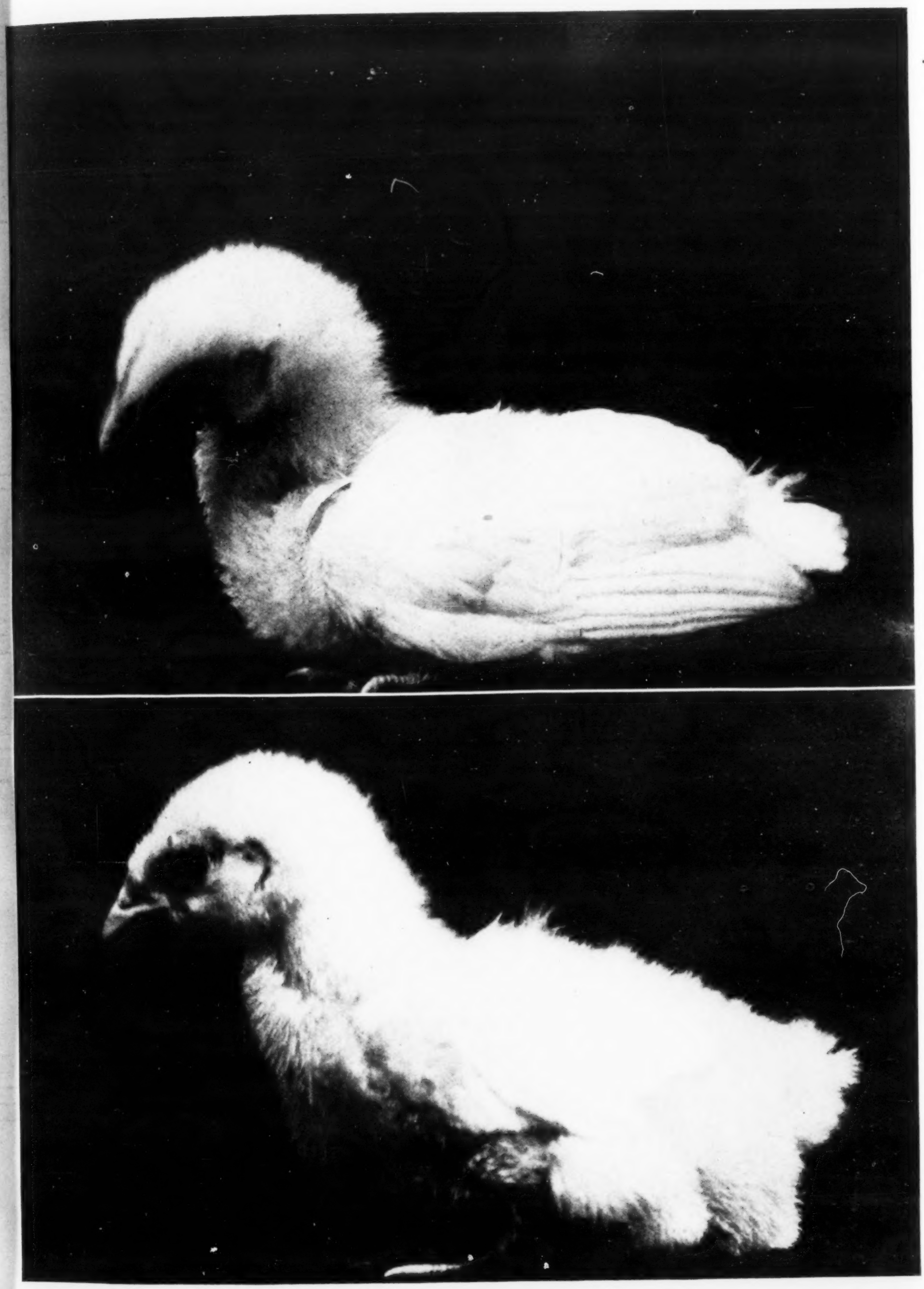
First Generation Female

CRISS-CROSS INHERITANCE THE

and

All four chicks were sixteen days old when photographed, and a hat
the daughters display the rate of feathering characteristic of the b whic
itance of this character follows the distribution of the sex-chromos is s

White Leghorn Male

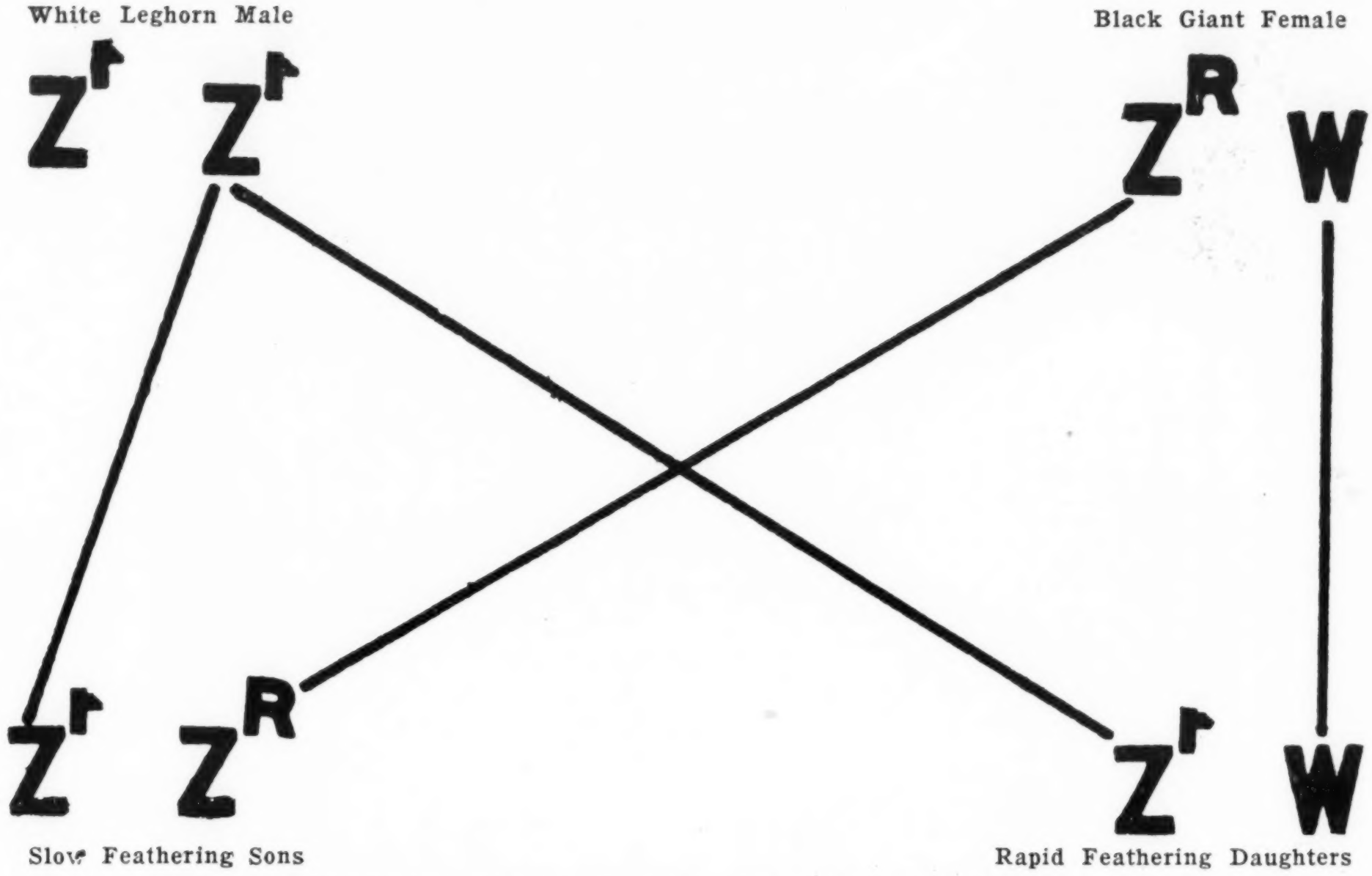


First Generation Male

THE RATE OF FEATHERING

and 5

nd a hatched at the same time and reared in the same brooder. Note that
he b which the father belongs, and the son that of the mother. The inher-
mos is shown diagramatically in Figure 6.



DISTRIBUTION OF THE SEX-CHROMOSOMES

Figure 6

This shows the gametic constitution with respect to the so-called W and Z chromosomes in the cross Black Giant female by White Leghorn male.

upon the rate of feathering. The character studied showed very clean-cut segregation since over six hundred individuals are here recorded and all but eleven fell in the two classes,—showing tails before the ninth or not until after the sixteenth day. The exceptional individuals appeared in the F_2 generation and were classified as rapid feathering since they all showed well defined tails before examination on the sixteenth day. For some reason they failed to develop tails within the usual period. A single examination made on the twelfth day would have given a correct classification of all chicks—recording as rapid feathering those showing tail feathers and as slow feathering those lacking them at that time. Individuals which as chicks had shown the different rates of feathering could not be distinguished as adults.

Experiments

Previous experimental and cytological work upon the domesticated fowl has indicated that here, as in the moths, the relation of the sex chromosomes is somewhat different from that found in most other animals. The male possesses two similar sex chromosomes which are usually represented by the symbols Z Z and the female possesses two unlike sex chromosomes which are indicated by W Z. A number of characters, known as sex-linked, have been shown to follow, in inheritance, the distribution of the Z-chromosome and are held to be due to genes located in that chromosome. Experimental work to date has failed to show that any genes are carried by the W-chromosome.

Mating A.—Black Giant Male by Leghorn Females

A Black Giant male was mated to four White Leghorn females. From this mating 98 offspring were examined, 46 males and 52 females, and all were "slow feathering," not showing tail feathers until after the sixteenth

day. Little can be learned from this cross except that slow feathering seems to be dominant over rapid feathering.

Mating B.—White Leghorn Male by Black Giant Females

A White Leghorn male was mated to two Black Giant females and 24 offspring resulted. The females, 13 in number, were all rapid feathering, (showing tails when examined on the ninth day) and the males, 11 in number, were all slow feathering, none showing tails before the sixteenth day. Here we have the sons showing the characteristic of the mother and the daughters that of the father, exhibiting what is known as criss-cross inheritance and indicating that the responsible factor is sex-linked. Figure 6 shows the gametic constitution of the parents and offspring in this cross. It is seen that the sons, receiving a Z-chromosome from each parent, will show the dominant one of the two contrasted conditions. From the previous cross it is seen that the slow feathering is dominant and, therefore, in this cross the sons should all be slow feathering. The daughters possess only one Z-chromosome, and since the W-chromosome does not carry its dominant allelomorph, will display the characteristic transmitted to them whether it be dominant or recessive. In this case they receive a Z-chromosome which carries the rapid feathering gene and exhibit that characteristic.

Mating C.—Back-cross of First Generation Males to Black Giant Females

Two F_1 males from the cross Black Giant male by White Leghorn female were back-crossed to twelve Black Giant females. From these matings two hundred and seventy-two chicks were examined and classified as follows: 127 males all slow feathering, 84 slow feathering and 61 rapid feathering females. As will be seen from Figure 6, the F_1 male (Z^r Z^R) which was used in this cross is heterozygous with respect to rate of feathering. The Black Giant females are of the constitution Z^R W. The daughters from this cross, receiving their only Z-chromosome from the father, have an equal chance of receiving the Z^r or the Z^R and would be expected to result in equal numbers of rapid feathering and of slow feathering individuals. The sons, receiving one of their paired Z-chromosomes from the mother and this chromosome carrying the dominant R, would all be expected to be slow feathering, as is the case.

Mating D.—F_1 Male Mated to Sisters

Two F_1 males from the cross Black Giant male by White Leghorn females were mated to five sisters. One hundred fifty-four chicks were examined from this cross and were classified as follows: 73 males, all slow feathering; 81 females, 43 slow feathering and 38 rapid feathering. From figure 6 it will be seen that the individuals used in this cross have the same gametic constitution as those in mating C and the resulting offspring should be the same. In both crosses the sons are all slow feathering and the daughters are approximately half slow feathering and half rapid feathering.

Mating E.—First Generation Females Back-crossed to White Leghorn Male

Two F_1 females from the cross Black Giant male by White Leghorn females were back-crossed to a White Leghorn male. Ninety chicks resulted and were classified as follows: 49 males, all slow feathering and 41 females all rapid feathering. Here the mothers are of the Z^R W constitution and the father of the Z^r Z^r constitution. The sons will all be Z^R Z^r or slow feathering and the daughters Z^r W rapid feathering.

Summary

In the case of the Single Comb White Leghorn and Jersey Black Giant breeds the factor which determines the rate of feathering is carried by the sex chromosome. This sex-linked char-

acter shows clean-cut segregation and is expressed early in life, making it a satisfactory character with which to work. The expression of the character does not seem to be affected by the vigor of the individual and the character cannot be recognized in the adult bird.

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[2]Serebrosky, A. S., 1922. Crossing Over Involving Three Sex-Linked Genes in Chickens. *Amer. Nat.* 56: 571-572.

TABLE I—Showing the Result of the Crosses Made for the Study of the Inheritance of Rate of Feathering

		Rapid feathering		Slow feathering		Total
		Males	Females	Males	Females	
Mating A	Black Giant male by White Leghorn females			46	52	98
Mating B	White Leghorn male by Black Giant females		13	11		24
Mating C	Back-cross of F_1 (from the cross Giant male to White Leghorn female) to Black Giant females		61	127	84	272
Mating D	F_2 from the cross Black Giant male to White Leghorn females		38	73	43	154
Mating E	Back-cross of F_1 females (from the cross Giant male by Leghorn female) to Leghorn male		41	49		90

The Decay of the Family

On the subject of divorce, the bishops declared that a "frightful condition" existed. They proposed as remedies the standardization of divorce laws of the various commonwealths, the immediate enactment of a federal divorce law to provide uniformity in dealing with the matter, and "a return to the former ideals of personal virtue, modesty and social propriety."

"The record is," the report asserted, "that 133,000 American families were wrecked by divorces in one recent year. * * * In the last twenty years, 3,767,000 men and women secured divorce papers. This involved 5,600,000 minor children * * * Can a more frightful condition be imagined?"—*Associated Press Report of Methodist General Conference.*

FORMALISM IN BREEDING OF LIVE STOCK IN RELATION TO GENETICS

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THE characters to be aimed at in breeding have, for the most part, been settled by judges at shows, but frequently fancy has played a decisive part in directly encouraging breeding for certain economic qualities. There is no doubt that the rivalry between breeders of beef animals has greatly contributed to the development of the present type in England.

Besides the above mentioned advantages, fancy has been the cause of fixing a certain color or the position of the horns as characteristic of a particular breed. This desire for uniformity has been especially dangerous in those species of domestic animals in which not all are raised. This tendency has been most strongly defined as regards colors, as these are seen on the new-born animal, which is slaughtered when it does not satisfy the demands of the standard.

In the case of horses, however, all the foals are kept, and therefore the tendency to uniformity is not so marked as in other livestock, except in certain instances, where matched animals are required, which justifies severe measures being adopted to insure uniformity.

In sheep-breeding, rigorous selection is practised with the object of obtaining a white fleece, which is of real economic importance, since white wool dyes more easily than colored wool.

The sheep-breeding industry has, however, suffered from formalism, to which must be attributed the demand for a black muzzle in white Cheviots, and although in spite of selection for many years, lambs with white muzzles frequently appear. This deviation from the accepted standard is considered of such importance that when a white-faced lamb is dropped by a Cheviot ewe, the fact is duly registered in the flock-book. Indeed, I have seen flock-books in which the color of the lamb's face was the only character entered. Brown patches on the ears and legs in the Cheviot breed are also looked upon with disfavor.

The thick covering of wool which is *de rigueur* on the head of Shropshires and many Merino breeds often interferes with the sight of the animals as the wool comes over their eyes.

In our country there is some reason in requiring that pigs should have a white color, for the consumers often object to a dark skin; but in southern lands, pigmented swine are superior to others because they resist the sun better. Pure formalism as regards color has, however, prevailed in some cases, since only the standard coat-color is admissible in Berkshires, Poland-Chinas, and other breeds.

The long, pendant ears of many of our native breeds of pigs are another instance of the tendency to formalism. The Large White should have a long, slightly turned-up snout, and rather long erect ears. These characters appear to be a heterozygous combination, for among the pigs of this breed there occur very frequently types with either the short snout of the Middle Yorkshire, or the long snout and pendant ears characteristic of the native swine.

This strict adherence to various standard points may have great disadvantages in the breeding of sheep and pigs and may exclude the use of breeding animals possessing the most important economic characters, although since these animals multiply very rapidly and

the number of individuals from which to select is large, formalism does not exert such a deleterious influence from the economic standpoint as in the case of other live-stock that multiply more slowly and whose sexual maturity is consequently later.

The formalist school has, however, applied its theories especially to that kind of domestic animal, which multiply very slowly, i. e., cattle. The color and pattern of the coat has been regarded as of paramount importance, so that black-pied cattle of the North Sea breed even, when most perfectly marked, have not been awarded a prize or entered in a herd-book if their legs showed the smallest black patch upon their white surface.

Indeed, in Holland the cows are sometimes sent at calving-time to a province where irregularly marked calves are eligible for registering in the herd-book.

The Hereford is a breed in which the requirements to patterns have been most rigorous. These cattle should have a white head, chest, and belly, white legs and tip to tail, while a white line runs along the back of the neck and on the withers. For at least seventy years, this breed has been selected in order to fix these particular coat-markings, but according to Pitt's researches the animals of the best herd are not homozygous for the factors that govern these patterns, and calves are regularly born with too much white about them.

Continuing with patterns, we find that both in the Pinzgau cattle of Salzburg as in that of our Telemark breed, certain uniform markings are established, but individuals deviating from the type occur constantly. The Pinzgau cattle are selected rigorously for the standard patterns, but calves constantly are dropped with too much white about them (despite that compulsory selection of bulls has been introduced by law and bulls with irregular patterns are barred). In the Telemark cattle it has partly been required that the thighs shall be colored, small patches of white ground being regarded as a deviation from the type; but both these types of markings are found in the progeny of pure-bred individuals. However, I am glad to say that the present management of the Telemark stock-breeding has given up these requirements.

An amusing instance can be cited of the manner in which a typical breed color has been obtained in Norway. Both cross-bred and pure-bred Ayrshires were generally kept at Trondelag at the beginning of the decennium of 1890. At that time a movement arose in Norway for encouraging the breeding of local cattle, and the management of the cattle breeding in Trondelag did all in its power to discover a local type as well as a national type. The first stage was the creation of the dun "Beistad" cattle, but as this type of color did not prove satisfactory, the management set to work to obtain from the Ayrshire breed and its crosses, cattle with a uniform red coat. The cause of this "local" idea was that on Frosta had emerged a unicolored red bull, who was homozygous and produced only unicolored calves.

The local movement of breeding in Norway offers a number of strange demands on colors. Of these the most characteristic is the demand for exclusively dun cattle in the Province of More. This color is due to a dominant dilution factor changing black into dun, or red into yellow. It thus happens that these dun cattle in the pure breed reproduce both black, red and yellow progeny, and besides often some light dun, nearly white individuals, none of which comply with the demands of the "type of breed." When a society in this county has been so unfortunate as to obtain a bull, heterozygous for a sufficient number of color factors it might happen that from small herds of six to ten cows not a single heifer calf would fill the demands as regards color.

The color of the muzzle is also paid much attention to. In Shorthorn breeds

a cloudy muzzle is an objection; in Germany this character excludes the animals from the herd-book, and also in Denmark severe lectures have been read over the black muzzle.

It is not only in colors that formalism in cattle breeding has occupied an important place. The horns and the position of the horns have been a favorite domain for busy authorities on cattle breeding. In Germany appliances for giving horns the required shape have often been advertised. The scurs occurring in polled breeds have been a great stumbling block and a large number of cows in Norway have been given a show rating one or two degrees lower for this reason.

As regards the conformation of cattle, many points are required in show animals, where a balance is kept between the purely formalistic and the wholly utilitarian standpoint. The demand for a well-formed udder thus has its direct practical importance in those districts where the cows are pastured on rugged ground. In other conditions too rigorous demands on the form can exclude cows of good economic characters. But regarding the external characters required in show animals many of them are of no practical importance, for instance, the objection against the sloping croup.

According to the researches of Gowen, the value of "milking marks" proves illusionary when milking records are kept. No study has been made of milking marks in bulls, but it seems unlikely that female characters in the phenotype of the male should influence its genotype.

It can well be understood that before the laws of heredity were known, much economic importance was attributed to the external characters of domestic animals. But now there is no reason to maintain the formal standards of the breeds, as we know that the chromosomes are the bearers of heredity in all living individuals that reproduce sexually and that heredity becomes more and more complicated in proportion to the number of chromosomes of the species in question.

The number of pairs of chromosomes present in the following animals is: In the horse, thirty; in swine, twenty; in cattle, sixteen or seventeen. In view of these figures we must recognize the great number of possible combinations. The twenty pairs of chromosomes in swine can thus be combined in practically an infinity of different ways.

In the breeding of domestic animals there are so many important economic characters to be selected for, and these characters depend upon such a large number of hereditary factors, that the breeder can not afford to pay attention to any qualities not having great practical importance.

The only reason justifying selection directed to obtaining a character of no economic value is that there exists a strong linkage between the hereditary factor producing this character and a factor producing a character of economic importance. Arenander has tried to show that there is a linkage between productivity of the polled-cattle and that of the horned. As, however, his work is by no means free of bias, I find it unnecessary to deal more closely with it. In short, on account of the large number of chromosomes possessed by our larger domestic animals it is very unlikely that there exist linkages so strong that they are of any practical utility.

The modern research of heredity shows clearly that the method adopted for the elimination of recessive, atypical breed characters is quite useless. Refuge has been taken in killing, or excluding from breeding, all animals that do not reach the required standard.

In most of these instances of formalistic selection, the difference between the typical and the atypical individuals depends upon a single hereditary factor, so that it is possible to calculate how quickly the number of recessives can be reduced by excluding these.

Suppose that there are in a herd at

first 1/4 dominant homozygous (pure) individuals, 1/2 dominant heterozygous (impure) individuals and 1/4 recessives, the number of the recessives will decrease in geometrical progression, and in the first generation, the proportion of recessives will be 1/9, in the second 1/16, in the third 1/25, etc.*

The number of heterozygous individuals will in its turn fall in the same proportion being in the first generation 4/9, in the second 6/16, in the third 8/25, etc.†

This, however, presupposes that the pure and the impure dominants have the same chance, but practically this is not the case. The "Great Sires" occur naturally amongst both the pure and the impure dominants. It must be remembered that in this combination if both the pure and impure had the same chance, the latter would be reduced to 15.3 per cent in the tenth generation, provided all the recessives had been eliminated during this time. Even in the tenth generation it is possible to meet with a "Great Sire" that is heterozygous as regards the factor in question, and then the result of the previous selection is soon lost.

We have in Norway a striking instance of the manner in which Great Sires have rendered abortive the efforts to obtain uniformity. Formerly it was required that the horse of the Eastland breed (Norway) should have either a black or a brown color. This goal had been almost reached because "Dalegudbrand 446" and "Draupner 613" were two black Great Sires in which the hereditary factor for red was lacking. The triumph was, however, of short duration. The successor of "Draupner" was "Brimin 825", who possessed the factor for red and thus the resistance to this color was broken.

Color transmission in the Aberdeen-Angus breed may be cited as an instance where the troublesome recessive factors have not been got rid of, even by the elimination of the recessive individuals. For at least fifty years, a selection of unicolored black individuals was carried out within this breed, but according to Watson, red calves or calves with the white spots on their legs, are of frequent occurrence.

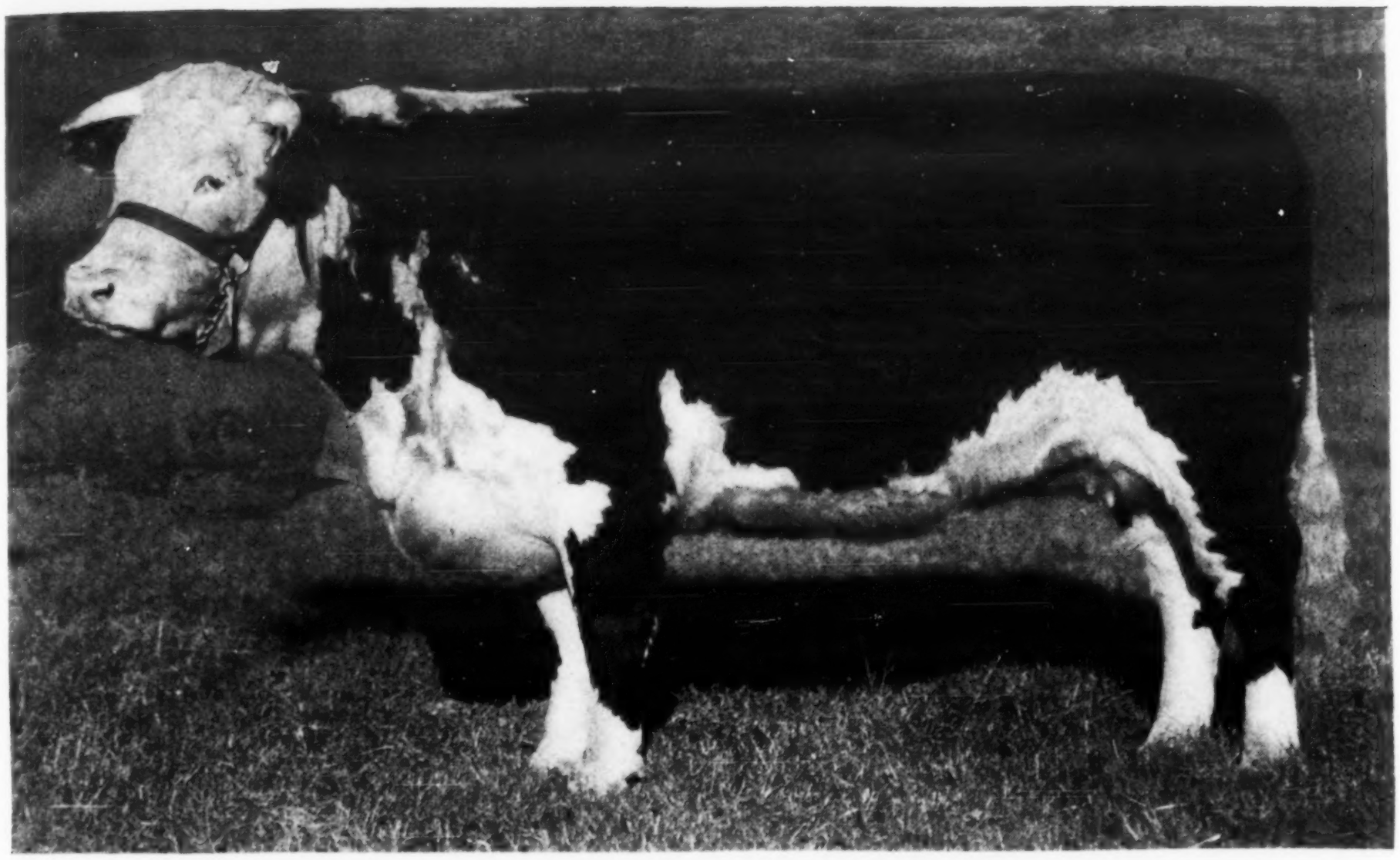
Naturally, it is possible to obtain a breed homozygous as regards the dominant heredity factor required, provided all individuals that are heterozygous for the recessive factors are eliminated, but no one would like to take upon himself the responsibility of rejecting a breeding animal with a good hereditary record of important economic qualities, even if it were heterozygous for an hereditary factor of no practical value.

It is quite certain that if the breeding authorities were, for instance, in a black breed to exclude from the herd-book and refuse prizes to all pedigree cattle producing red calves, the birth of such calves would very rarely be known or recorded. The struggle against characters depending upon hereditary recessive factors is, and will remain, fruitless; therefore there is no reason in burdening the practical breeder with the expense entailed.

It is different where we have to do with characters depending on hereditary factors that have proven to be more or less completely dominant. In this case, it is possible to eliminate entirely all undesirable characters, although great injury may be caused if this elimination is pushed to undue lengths. We are well aware from the study of the pedigrees of the various breeds that the individuals forming the original stock and maintaining the breeds were few in number and that some of them may

*The formula for calculating the number of recessives is as follows: $\frac{1}{(n+2)^2}$; n being the number of generations.

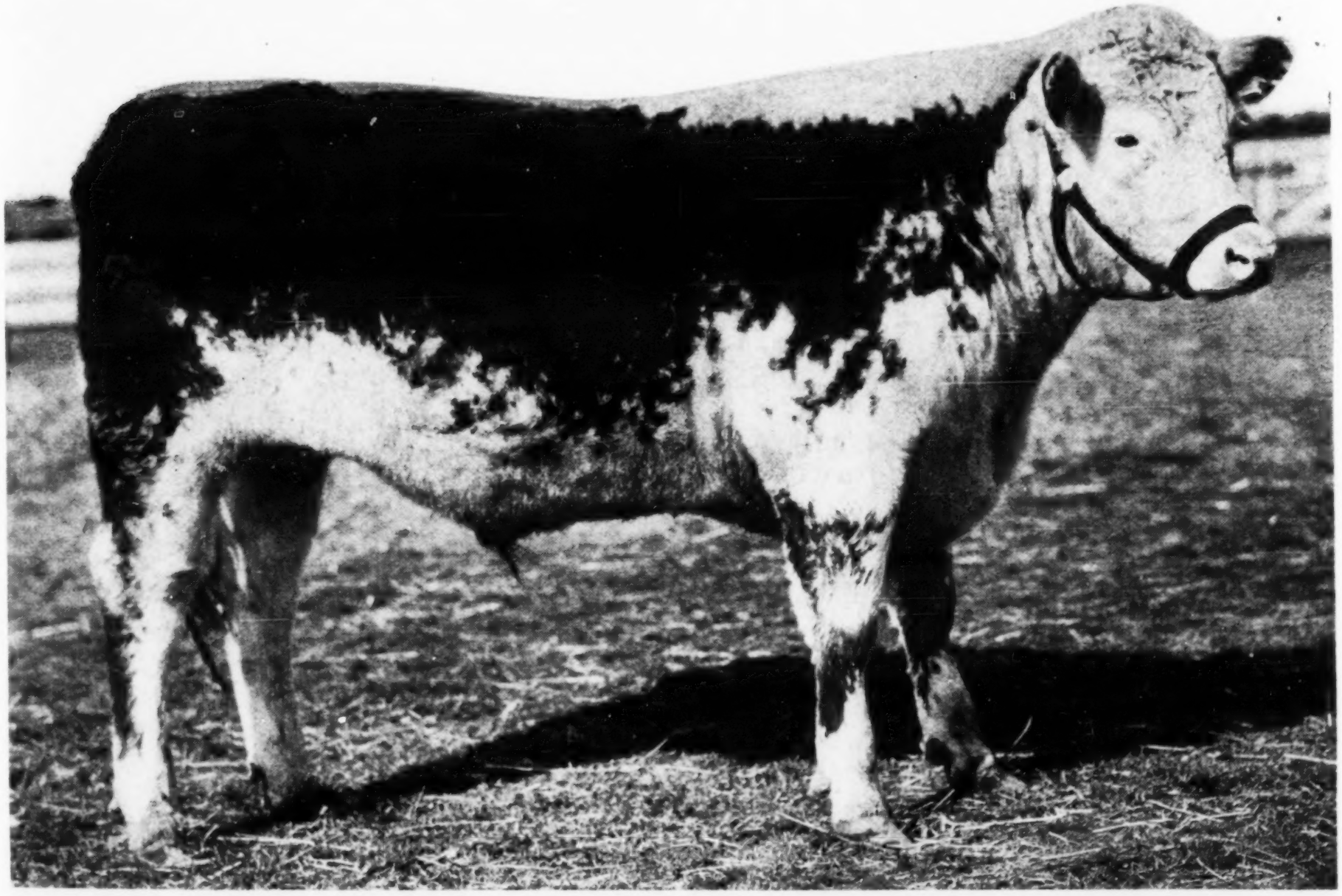
†The formula for the number of heterozygous individuals is: $\frac{2\,(n+1)}{(n+2)^2}$; n being the number of generations.



A TYPICAL HEREFORD

Figure 7

In the Hereford Breed the requirements regarding color and pattern have been rigorously maintained for seventy years. Nevertheless calves with too much white about them still appear frequently, even in the best herds.



HEREFORD WITH TOO MUCH WHITE

Figure 8

From the livestock judge's point of view this departure from the recognized pattern is a serious objection, but genetic research has brought to light no evidence of linkage between color patterns and characters of economic importance, the only sound reason for insisting on uniformity in non-economic characters.

have been the offspring of animals possessing an undesirable hereditary dominant factor. The English race-horse is a striking example of this possibility and affords an instance of the manner in which a stallion possessing a rare dominant character has been one of the principal sires in the breed. This stallion is the grey "Tetrarch," whose offspring in recent times have been among the first in the list of winners and one year even the first. The grey color which depends on a dominant factor was before the time of "Tetrarch" very uncommon among English blood, but nevertheless a Great Sire with this color was born.

As regards the characters dependent on hereditary factors that are more or less dominant and have no direct importance, there is every reason to be careful in eliminating them.

In all, the modern researches on heredity and pedigree research clearly show that in the economic breeding of domestic animals we can not afford to select for other charcters than those which are of direct or indirect economic importance.

Eugenics in Sweden

THE SWEDISH NATION in Word and Picture: a Jubilee Book given out, with the cooperation of experts commissioned by the Swedish Society for Race-Hygiene, by H. LUNDBORG, M. D. and J. RUNNSTROM, Ph. D. Stockholm, 1921.

Sweden is in a more favorable position than some other countries to further the interests of eugenics. It has pride of race; its population is largely composed of one race (the Nordic); it has a good level of intelligence; it possesses unsurpassed demographical material in its parish registers, which form the basis of the national census; and it has had an active body of geneticists to provide the theoretical foundation for attempts at improving the human race. All of these conditions, and their consequences, are fully described in the present book, written in English and beautifully printed.

The research work of Swedish geneticists and eugenists is so well known as to require no review here. The educational propaganda for eugenics is being pushed by a number of different societies, particularly the one which publishes the present volume. Legislative advances have very properly been moderate; but Sweden now has a reasonably adequate marriage law, and appears to be making progress toward prohibition of the use of alcohol.

Not the least interesting part of the volume is the collection of illustrations, representing not only most of the scientists engaged in genetics and eugenics, but a number of representative leaders in other fields of creative activity, together with a beautiful series of "types," which portray not only the more or less pure Nordic, but the Finns, Lapps, Walloons, and other elements found in Sweden, together with some of the hybrids of these various races with the Nordic. P. P.

ESSAYS ON CELLULAR STRUCTURE AND FUNCTION

(A Review)

THE appearance of a new text on *General Cytology** is likely to interest a large group of Biologists. A generously illustrated text attempting to present a modern treatise of the subject that will be equally useful to botanists, zoologists, physiologists and pathologists should meet with an enthusiastic reception.

The reviewer is disappointed to find *General Cytology* made up largely of groups of essays of individual investigations. Such a treatise would require as many theses as there are investigators to be "General." The introduction prepares the reader for a comprehensive insight of the structure and function of the cell. The opening chapter succeeds in making our conception of cytology so elastic that we soon are reading a discussion of the energy transmission through the universe under the heading *Chemistry of the Cell.*

Electricity and the Cell

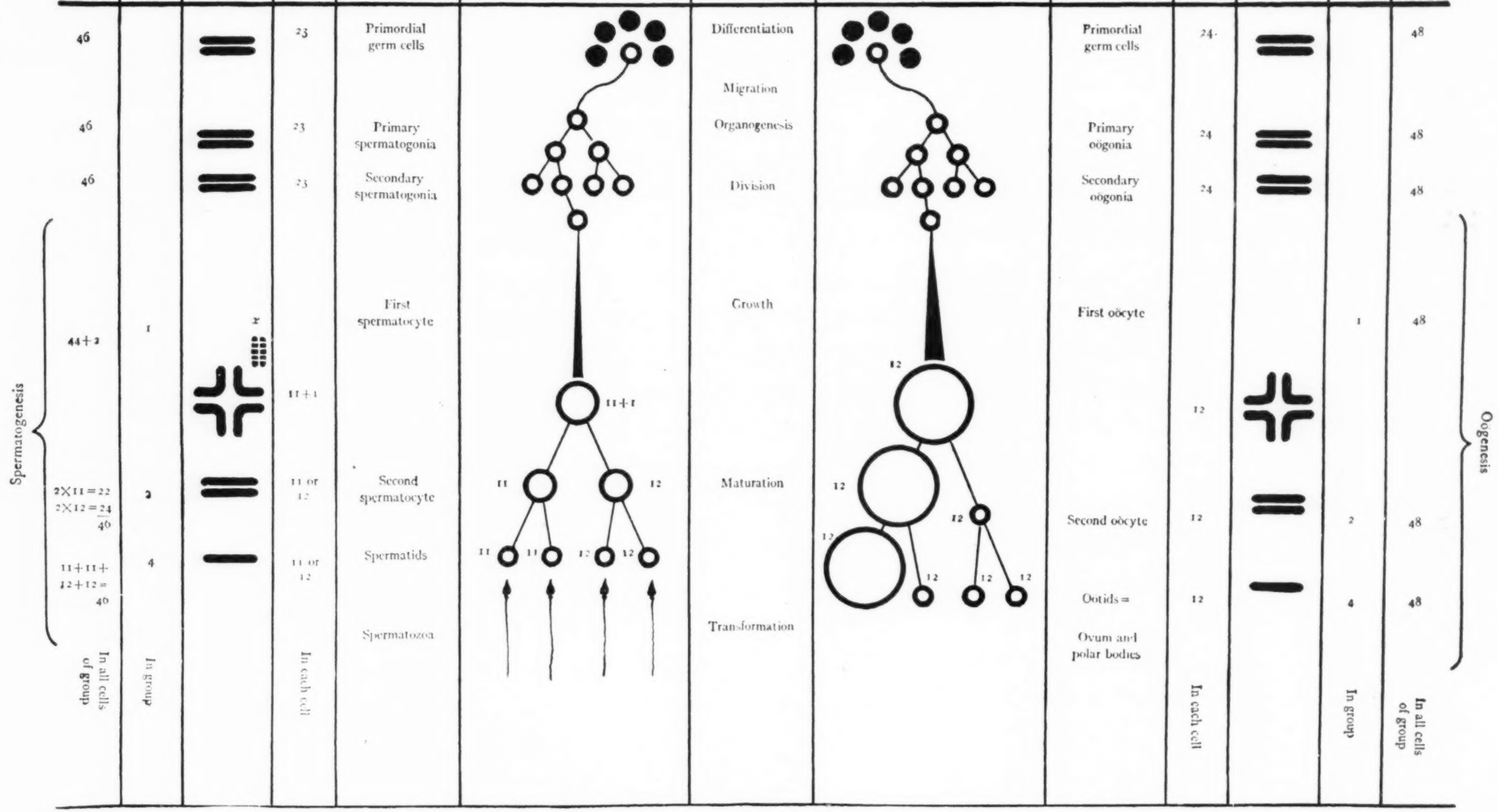
The casual reader will be almost carried away with A. P. Mathews speculative and ultra modern theory of life as it is presented. Life, according to his theory, has been simplified until it is now measurable in terms of energy. There is the energy rich or living, and the energy poor or dead, electron, atom, molecule and protoplasm, all depending upon the position of some one or several electrons in an atom—stability meaning death, instability, life.

The physiologist will pause many times while the morphologist hurries over the first third of the book eager to reach the discussion of more tangible matters. Nevertheless, the reviewer is impressed and, at times, almost tingles with the realization that innumerable electrical currents are associated with every activity of each living cell of an organism, and that the continual changes in cellular potential, and the passing of minute electrical currents hither and thither, act as the regulators and messengers of the polyphasic and protoplasmic system of the cell, and thus regulate and control every activity of his body.

The one-time slave of killing fluids and Canada balsam will be keenly interested in the work that has been done with living cells growing in tissue cultures and dissected on the table of the microscope. Such studies cause one to realize the profound changes that take place when a cell is killed. There is every reason to believe that microdissecting instruments in the hands of skilled investigators are likely to become of primary importance to cytologists. With them the cellular and nuclear membranes can be probed and torn, the viscosity changes in the protoplasm detected, and solid cellular inclusions handled in miscroscopic hands thus the texture and structure of mitochondria, plastids, crystals, chromosomes, etc., may be critically studied.

The writer is interested primarily in Botany, and after reading a chapter discussing three cytological constituents of the cell is disappointed to find no general treatise of cellular inclu-

**General Cytology*, by EDMUND B. WILSON, ALBERT P. MATTHEWS, MERKEL H. JACOBS. RALPH S. LILLIE, ROBERT CHAMBERS, CLARENCE E. MCCLUNG, EDMUND V. COWDRY, WARREN H. LEWIS, MARGARET R. LEWIS, FRANK R. LILLIE, EDWIN G. CONKLIN, THOMAS H. MORGAN, and EVERETT E. JUST, edited by E. V. COWDRY, The Rockefeller Institute for Medical Research, New York City. Pp. 754. Price $7.50. The University of Chicago Press, Chicago, Ill., 1924.



GERM CELL HISTORY IN MALE AND FEMALE

Figure 9

This chart gives a diagrammatic comparison of cell and chromosome behavior in the production of germ cells. In the species shown there are twenty-three chromosomes in the male cells, and twenty-four in the female cells, the "x-chromosomes" being unpaired in the male. This produces equal numbers of two kinds of spermatozoa, having eleven and twelve chromosomes respectively. Sex is determined by the type of spermatazoon which takes part in fertilization. From *General Cytology*, the University of Chicago Press.

sions in plants—plastids, crystals and stored foods such as starch, inulin, etc., all vital to the life of the plant and frequently useful as indicators of pathological conditions. The same criticism may be made after reading the account given on fertilization. So much of life on our earth has evolved above the sea level that it seems there should be some discussion of such interesting fundamental discoveries as the fertilization processes that characterize our higher plant life.

The Chromosomes

Chromosomes, as the carriers of hereditary characters, in the form of linearly arranged chromomeres or genes, are the basis on which the more fundamental genetic laws, at present, stand.

Chromosomes have attained this prominent position because of their constancy in organization and behavior in a large taxonomic group, the definite association between particular chromosomes and certain characters, and the parallelism between behavior of chromosomes in maturation and fertilization, and the behavior of characters in inheritance. The demonstration of chance segregation of paternal and maternal elements in maturation and chance recombination of homologues in fertilization, and the persistence of chromosome organization as an evidence of specific taxonomic value, has given the "Chromosome theory of heredity" its present standing in the biological world.

The views of C. E. McClung are substantiated by helpful reviews of recent investigations that have done much toward confirming the "Chromosome theory of heredity," but he passes over very lightly the cytoplasmic theory of heredity, and the end to end fusion of chromosomes, both points affecting profoundly the theory in question. He seems to err as with others of his colleagues in illustrating his discussion generously from the works of sympathetic investigators, but the discordant results of other investigators are not discussed.

The gene, also, seems to be no longer a speculative concept in the minds of geneticists. The innumerable demonstrations of groups of linked characters, and the crossover and double crossover ratios between such characters have enabled the investigator to map the theoretical position of genes in a chromosome in such a convincing manner that a linear arrangement for them is now generally accepted.

The cytologist has been slow to confirm a linear arrangement of character bearing genes by actual observations, but has made an important step by demonstrating the constancy of size and position of chromomeres in a chromosome.

As a concluding criticism, this voluminous publication appears to the writer as a book of *one* theories—one theory of life, one theory of stimulation, one theory of cellular differentiation, and one theory of chromosome reduction. In many cases the theory chosen was the one that fitted the author's method of research; and it is to be regretted that all authors did not include short discussions of the more important opposing theories.

General Cytology in the hands of advanced zoological and medical students is likely to find an important place. To the working cytologist there are two major and helpful points in this co-operative discussion of his field. First, he will be carried away from his narrow views and see the field with its expanded boundaries. Secondly, he will be greatly helped by the generous citation of literature that he so frequently requires.

—*A. E. Longley.*

INHERITANCE OF HEMOPHILIA

BESS LLOYD
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AN INVESTIGATION of the families of two patients suffering from hemophilia revealed a mode of inheritance of the disease not altogether in agreement with that in a large number of other families previously studied, where hemophilia is transmitted as a sex-linked recessive Mendelian character.

The accompanying charts give the pedigrees of these two families, Chart 1 representing four generations in an American family in which the disease was severe in each case. Chart 2 shows the inheritance of this disease in a Russian family of which only the last generation was born in this country.

The patient III-14 Chart 1 has suffered as a bleeder all his life. As a child he had profuse epistaxis (nosebleed) from slight injuries on the head. These attacks would continue as long as eight days with occasional periods of rest for a few hours. At the removal of his first teeth he was in a serious condition and a physician's services were necessary. Swellings of his hands, elbows and knees occur quite frequently, followed by discoloration and severe pain. Chronic tonsillitis and colds are always accompanied by swelling and stiffness in the joints. Following a severe strain from pain a large swelling, described as an aneurysm, developed under his jaw and increased in size until it hung down on his chest. His tongue turned blue and became swollen, almost choking him. The swelling was reduced but moved on down his neck and over his chest and abdomen. The discoloration and swelling gradually disappeared. Hematomas of the arms and thighs are frequent but do not spread below the joints.

The clotting time recorded at various admissions to the hospital varied from thirty minutes to four hours and thirty minutes.

The family history of this patient shows distinct inheritance for at least four generations. Two brothers of the patient show no symptoms of the disease, three of the five sisters seem to be affected and three baby girls died from hemorrhages. The affected sisters had severe hemorrhages at childbirth and menstrual periods but no other causes seem to produce extreme bleeding.

The oldest sister, III-5, is affected but has two normal daughters. III-7, affected, has a son who is a bleeder and two normal daughters. The son, IV-3, has had symptoms of a bleeder since he was one year old. Discolored areas develop from slight bruises and severe bleeding resulted from cuts and injured on the head. Another sister, III-9, who also is affected has one affected son, two normal sons and two normal daughters. The son, IV-7, has shown symptoms of a bleeder since he was five years old. A slight cut caused continuous bleeding for four days. He also is subject to swelling of the joints and discolored areas.

The mother, II-6, of the patient seemed normal. She had had eleven children, three of whom died in infancy from hemorrhages; the others have been mentioned previously. The mother's sister, II-1, had three sons all of whom were affected. Her oldest son, III-1, had frequent attacks of swollen joints and epistaxis. He died at the age of twenty from internal hemorrhages resulting from a fall. The second son, III-2, died at an early age from tyhoid fever and hemorrhages. The third child died in infancy from a hemorrhage.

The grandfather 1-2, of the patient,

Chart I

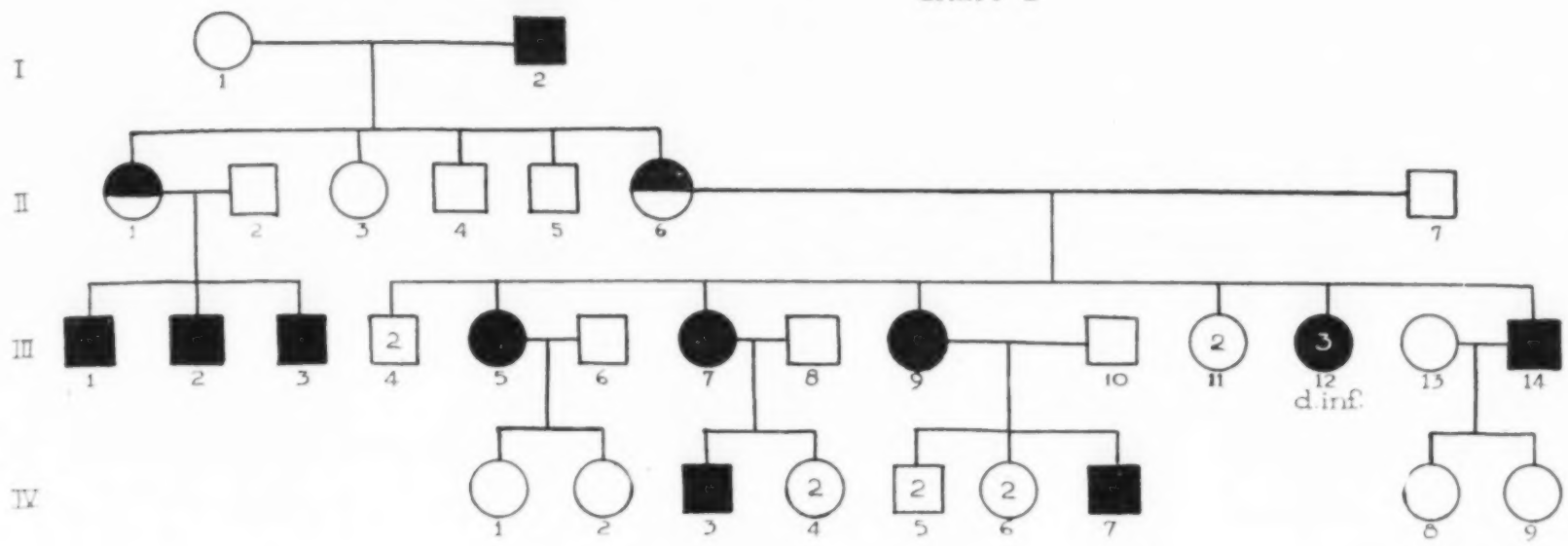
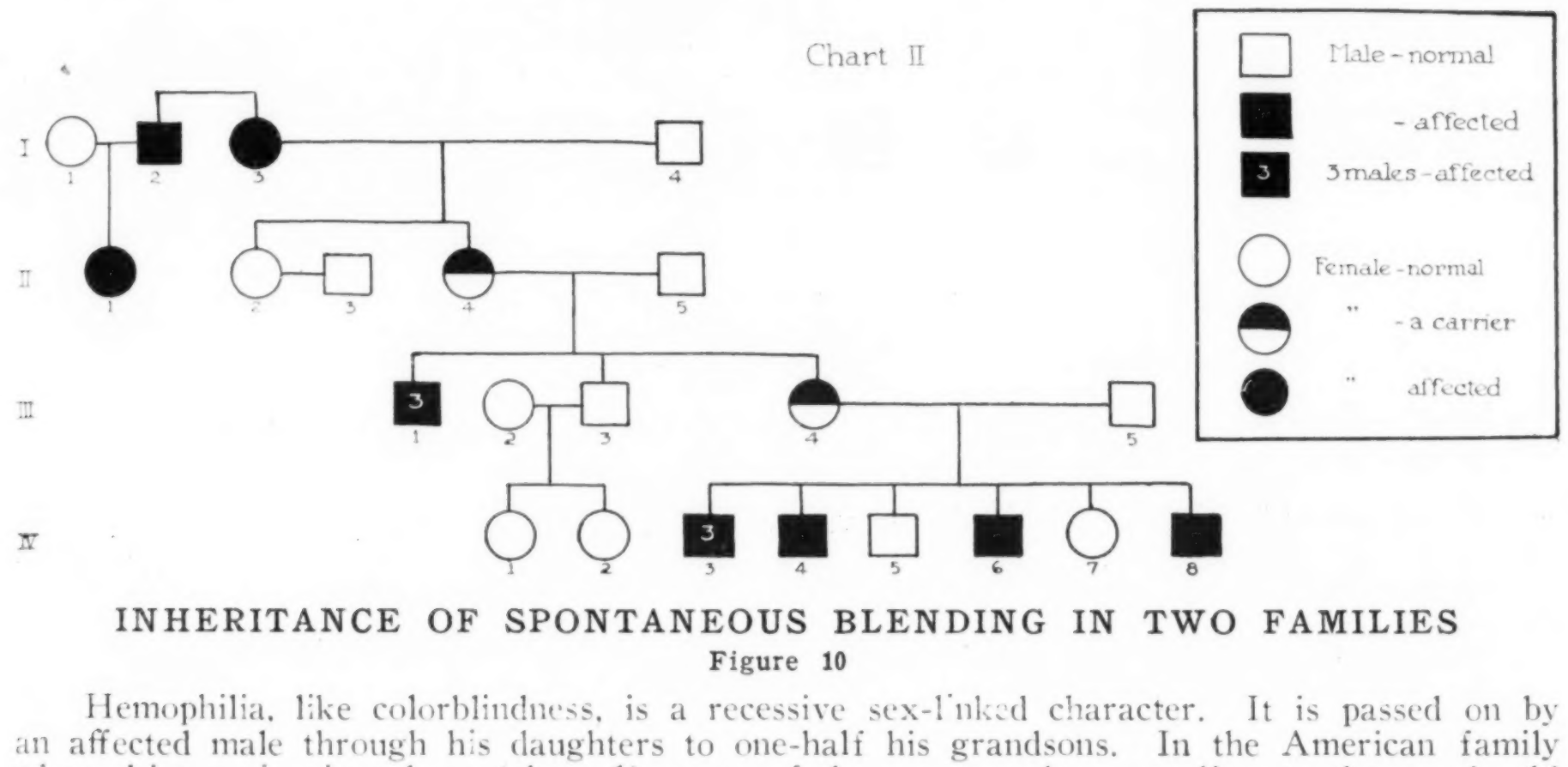


Chart II



INHERITANCE OF SPONTANEOUS BLENDING IN TWO FAMILIES

Figure 10

Hemophilia, like colorblindness, is a recessive sex-linked character. It is passed on by an affected male through his daughters to one-half his grandsons. In the American family whose history is given here (chart 1), some of the women who according to theory should be "carriers" actually show indication of bleeding. This is probably due to the incomplete dominance of the normal condition, the recesive character "showing through" to a certain extent.

died in the Civil War from a gun-shot wound. It was reported that the bleeding could not be stopped. He had suffered from frequent hemorrhages and bleeding of the kidneys.

In the Russian family, the boy IV-4 (Chart 2) was the first to be observed. He came to the hospital during a period of bleeding from the gums which lasted five days. These attacks were quite frequent. He had previously had a tooth extracted and bled for eight hours. He was subject to discolorations from slight knocks and bruises. The urine is often bloody, attacks of epistaxis occurred occasionally, and slight cuts resulted in hemorrhages. The coagulation time recorded varied from seventeen to twenty-three minutes.

A younger brother, IV-6, was brought in while bleeding from a cut. He has shown symptoms of a bleeder since he was four years old. Since then he has had frequent attacks of bleeding from the tongue, gums and membranes which occur about every three months and last from two to seven days. Slight injuries cause swellings and bluish discoloration but no stiffening of the joints was noticed. He has frequent attacks of epistaxis, multiple hematomas and occasional abdominal hemorrhages. The coagulation time recorded was twenty-three minutes.

The three oldest children in this family were boys and all died in infancy from hemorrhages. The young-

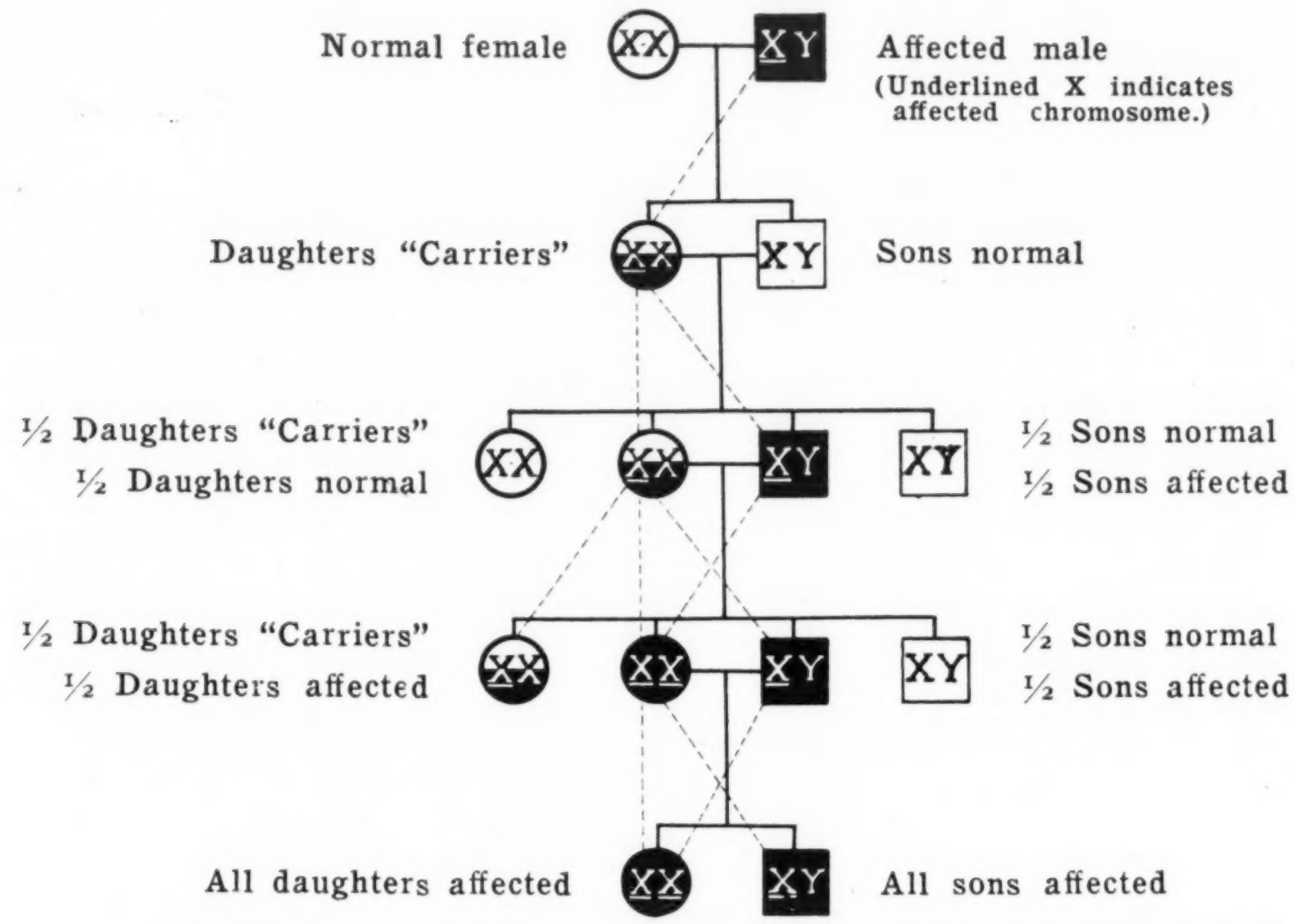


CHART TO ILLUSTRATE INHERITANCE OF BLEEDING

Figure 11

A sex-linked character is carried in the so-called X-chromosome, of which there are two in the female cell and only one in the male. Since the male "Y-chromosome" does not carry the normal complement or allelomorph, all males having one affected X-chromosome show symptoms of bleeding, while two affected chromosomes are necessary to show the character in the female. Thus male "bleeders" are much more common than female.

est IV-8 died from internal hemorrhages resulting from a fall.

The mother of these children had four brothers, three of whom died from hemorrhages at circumcision. It is peculiar that neither the maternal grandfather nor his family showed symptoms of being bleeders. The maternal grandmother and her family have no records of bleeders but the great-grandmother on the maternal side had hemorrhages and was subject to discolorations from slight bruises as is typical of the affected males. Her brother was also a bleeder and his daughter had frequent epistaxis, hemorrhages and profuse bleeding from cuts.

According to the Mendelian expectation, six classes of matings would be expected to produce or transmit hemophilia, of which only four concern us here. Five of these are shown diagrammatically in Figure 11, and in the mating affected Female X Normal male all daughters would be "carriers" and all sons would be affected.

If the dominance of the normal condition is complete we would not expect the "carriers" to show any evidence of excessive bleeding, which appears to be generally true in the inheritance of hemophilia. In these families, on the contrary, several of the females show symptoms of hemophilia, although they generally are not as severely affected as the males. If we consider these as "carriers" in whom the recessive character "shows through" to a varying extent, all these cases are brought into agreement with the accepted mode of inheritance. Such an explanation would be necessary to account for the case of the woman III-9 (Chart 1), who is a pronounced bleeder and yet has a normal son. This would not be possible if she were a true female bleeder, homozygous for hemophilia. In that case, all her sons would be affected.